

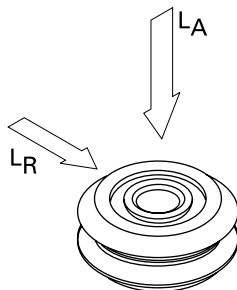
# The Load/Life Relationship

Several factors influence the service life of a DualVee® linear guide. Through research and development spanning over thirty years, BWC has devised a simple method to estimate the load/life relationship for a specific DualVee® guide mechanism under defined loading conditions. The methodology accounts for the size of the DualVee® bearing elements, relative spacing, and the orientation, location, and magnitude of the load. The curve is based upon clean and well lubricated track conditions; so for applications where lubrication is prohibitive, a derating factor must be applied.

It is important to note that secondary considerations such as maximum velocity, acceleration rates, duty cycle, stroke length, environmental conditions, the presence of shock, vibration and extreme temperature ranges can all impact service life to varying degrees. As such, the sizing method outlined below should be used conservatively, and considered only as a guideline for the sizing of DualVee® components and assemblies. When time and budget permits, the prototyping of a DualVee® arrangement is recommended to confirm service life expectations.

## The Load/Life Equation - Sizing and Selection

The load/life estimation requires a basic understanding of the principles of statics, the ability to work with free-body diagrams, and the capacity to resolve externally applied forces on a carriage assembly into the radial and axial reaction forces at each guide wheel in the design. The life of a DualVee® guide will be limited to the life of the most heavily loaded bearing in the design.



**Step 1:** Calculate the resultant radial and axial loads reflected to each bearing element in the linear guide design.

All standard considerations involved in statics calculations must be accounted for, including inertial forces, gravitational forces, external forces such as tool pressure, bearing element spacing, magnitude and direction of the payload. Any external forces that generate a reaction through the wheel/track interface need to be considered. If assistance is required in resolving specific loads into the resultant reaction forces at the guide wheel interface, contact our applications engineering staff for support.

**Step 2:** Calculate the load factor for the most heavily loaded bearing.

$$L_F = L_A / L_{Amax} + L_R / L_{Rmax}$$

Where  $L_F$  = Load Factor

$L_A$  = Resultant axial load on the guide wheel

$L_{Amax}$  = The maximum axial working load capacity of the guide wheel

$L_R$  = Resultant radial load on the guide wheel

$L_{Rmax}$  = The maximum radial working load capacity of the guide wheel

- Bearings should be sized such that  $L_F \leq 1$
- The most heavily loaded bearing will have the highest load factor

Due to varying application load, speed parameters and environmental conditions, the appropriate adjustment factor must be applied to the maximum axial and radial working load capacities ( $L_{Amax}$  and  $L_{Rmax}$ ) as follows:

Adjustment Factor	Application Conditions
1.0-0.7	Clean, low speed, low shock, low duty
0.7-0.4	Moderate contaminants, medium duty, medium shock, low to medium vibration, moderate speed
0.4-0.1	Heavy contamination, high acceleration, high speed, medium to high shock, high vibration, high duty cycle

Oscillating motion resulting in less than one full revolution of the wheel under load can cause accelerated wear on the internal bearing elements. Testing of such systems is recommended to verify compatibility of the design with load/life requirements.

# DualVee Guide Wheel Load Capacities

Part Number	DualVee Guide Wheel Load Capacity (lbf)						DualVee Guide Wheel Load Capacity (N)					
	Radial Working Load Capacity <sup>3</sup>	Axial Working Load Capacity <sup>3</sup>	BDLR Radial <sup>1</sup>	BSLR Radial <sup>2</sup>	BDLR Axial <sup>1</sup>	BSLR Axial <sup>2</sup>	Radial Working Load Capacity <sup>3</sup>	Axial Working Load Capacity <sup>3</sup>	BDLR Radial <sup>1</sup>	BSLR Radial <sup>2</sup>	BDLR Axial <sup>1</sup>	BSLR Axial <sup>2</sup>
	LRmax (lbf)	LAmx (lbf)	(lbf)	(lbf)	(lbf)	(lbf)	LRmax (N)	LAmx (N)	(N)	(N)	(N)	(N)
W1	134	57	490	250	245	234	595	252	2180	1110	1090	1040
W2	322	140	1057	625	535	591	1431	625	4700	2780	2380	2630
W3	691	382	2057	1135	1012	1079	3074	1701	9150	5050	4500	4800
W4	1058	899	2878	1776	1428	1675	4704	4001	12800	7900	6350	7450
W0X	59	28	236	112	119	106	265	123	1050	500	530	470
W1X	134	57	490	250	245	234	595	252	2180	1110	1090	1040
W2X	322	140	1057	625	535	591	1431	625	4700	2780	2380	2630
W3X	691	382	2057	1135	1012	1079	3074	1701	9150	5050	4500	4800
W4X	1058	899	2878	1776	1428	1675	4704	4001	12800	7900	6350	7450
W4XXL	1702	1473	4631	3215	2338	3035	7571	6552	20600	14300	10400	13500
W1SSX	134	57	490	250	245	234	595	252	2180	1110	1090	1040
W2SSX	322	140	1057	625	535	591	1431	625	4700	2780	2380	2630
W3SSX	691	382	2057	1135	1012	1079	3074	1701	9150	5050	4500	4800
W4SSX	1058	899	2878	1776	1428	1675	4704	4001	12800	7900	6350	7450
W4SSXXL	1702	1473	4631	3215	2338	3035	7571	6552	20600	14300	10400	13500
W0SSCR	49	23	196	93	99	88	220	102	872	415	440	390
W1SS227	111	47	407	207	202	196	494	208	1810	920	900	870
W2SS227	267	117	877	519	445	490	1188	520	3900	2310	1980	2180
W3SS227	574	314	1709	944	832	899	2554	1399	7600	4200	3700	4000
W4SSCR	876	746	2383	1475	1185	1389	3896	3320	10600	6560	5270	6180

**Step 3:** Apply the load factor to the load/life equation below:

$$\text{Life} = L_C / (L_F)^3$$

Where  $L_F$  = Load Factor

$L_C$  = Life Constant

Life constants are provided in both inch and metric as tabulated.

DualVee Size	Life Constant	
	inches of travel life	kilometres of travel life
0	1.65 x 10 <sup>6</sup>	41
1	2.19 x 10 <sup>6</sup>	55
2	3.47 x 10 <sup>6</sup>	87
3	5.19 x 10 <sup>6</sup>	130
4	6.84 x 10 <sup>6</sup>	171
4XL	8.58 x 10 <sup>6</sup>	215

Notes:

1. Basic Dynamic Load Rating, According to AFBMA STD 9-1990. Based on industry standard bearing calculations and are for comparison purposes only. Maximum working load figures should be used for component sizing and selection.
2. Basic Static Load Rating, According to AFBMA STD 9-1990. Based on industry standard bearing calculations and are for comparison purposes only. Maximum working load figures should be used for component sizing and selection.
3. Working load capacities reflect clean, well lubricated wheel/track interface.

# Operation Considerations

## Lubrication

Lubrication is the key to maximizing the life of a DualVee® linear guide. Internally, DualVee® guide wheels are lubricated for life with an extreme pressure, corrosion resistant grease. However, lubrication of the wheel/track interface is the responsibility of the user. A light machine oil or an extreme pressure grease will serve well in minimising wear, stick slip and corrosion on the guide ways in a DualVee® based design.

Lubrication will maximise the load capacity of an individual bearing element. As such, for any specific application loading condition, the presence of lubrication on the guide ways will significantly increase the service life over a non-lubricated configuration under the same loads.

Lubrication will also increase the maximum linear velocity that a DualVee® bearing arrangement can endure. In applications where high speed or high acceleration rates are present, lubrication of the wheel/track interface is highly recommended. Lastly, lubrication will reduce the overall coefficient of friction of the guide, which, depending on the level of preload, can fall anywhere from 0.008 to 0.015. The availability of lubricators and wheel covers gives design engineers an opportunity to design lubrication right into the DualVee mechanism with little effort. See specifications on wheel covers and lubricators for more detail.

## Track Splicing Considerations

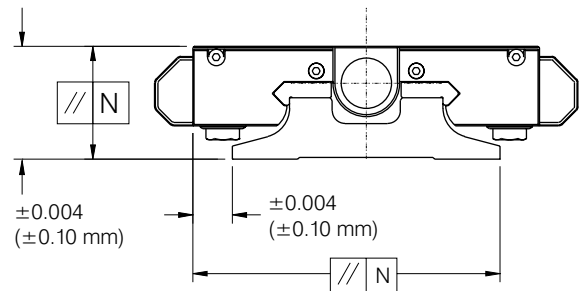
Precut lengths of track are not suitable for butting end to end. Please contact the factory when track lengths longer than the maximum available single piece lengths are required. Track that is suitable for butting is available on request. When constructing track systems longer than 20 feet, the joints on parallel tracks should be staggered for greater accuracy and smoothness.

Precut lengths of DualVee® track plate assembly are not suitable for butting end to end. Where track plates longer than the maximum length are required, please consult T.E.A. for butt-joining recommendations.

## Accuracy

Using DualVee Motion Technology®, achieving straightness and flatness characteristics to within N grade accuracy levels is fairly routine ( $\pm 0.004$  inch;  $\pm 0.10$  mm). In fact, accuracies as low as  $\pm 0.001$  inch ( $\pm 0.03$  mm) have been achieved using carefully prepared mounting surfaces in relatively short stroke applications (1-3 feet; 0.3-1 m). For designs requiring accuracy levels of  $\pm 0.005$  inch and better, mounting surfaces must be prepared straight and flat, and appropriate doweling or reference edge assembly techniques must be employed.

In most DualVee® applications, accuracy plays a small role in successful implementation and in such cases, cold finished or extruded bars provide adequate mounting surfaces for DualVee® raceway design. Mounting surface reference edges no longer require a chamfer, as the DualVee® track design has been upgraded to include a relief in the locating shoulder.



**Figure 1: Running parallelism end view**

<b>For single carriage measured at any point along the rail:</b>
Variation in carriage height: $\pm 0.004$ inch ( $\pm 0.10$ mm)
Variation in carriage width: $\pm 0.004$ inch ( $\pm 0.10$ mm)
<b>For multiple carriages measured at the same location along the rail:</b>
Variation in carriage height: $\pm 0.001$ inch ( $\pm 0.025$ mm)
Variation in carriage width: $\pm 0.001$ inch ( $\pm 0.025$ mm)

**Figure 2: Allowable tolerances for straightness and flatness of travel - grade N**

# Operation Considerations cont.

## Track Hardening

For maximum loading and heavy continuous use, the "T" series hard edge track should be used. For prototype or light duty intermittent use, the "TS" series (unhardened, as formed) track can be used at a lower cost.

## Contamination/Wear Resistance

Since the circumference of the wheel is greater at the major diameter than at the minor diameter, there is a constant wiping action on the track producing a self cleaning effect. As such, DualVee® guide wheels are employed in a wide variety of harsh environments, including the presence of metal chips, powders, fibres, slurries, etc. It is important to note that such environments will often limit the service life of a DualVee® linear guide to some extent. Since environments vary from application to application, it is recommended that DualVee® systems be prototyped before employing on a large scale. For instance, an OEM who is building a paper processing machine may want to prototype a linear guide in application where the guide ways are exposed to unique combinations of chemicals and paper fibres. It's difficult to predict exactly how the materials will behave in many cases. For instance a fine, yet hard powder material may accelerate wear in one case but simply be swept aside in another, depending on parameters such as particle size, temperature, humidity, and lubrication. Regardless, DualVee® is clearly the choice of antifriction linear guide technology in difficult environments, particularly when success is mandatory and reliability is critical.

The other main factor affecting wear resistance is lubrication. Wheel covers or lubricators should be designed in whenever possible. Both will distribute a thin coating of oil lubricant along the contact surface of the DualVee® track. The wheel covers offer added protection by preventing debris from entering the wheel/track contact surface. Lubricated and relatively clean wheel/ track contact surfaces will ensure maximum service life in a DualVee® linear guide.

## Fit-Up Adjustment

The stationary bushings determine the alignment of the system. They should carry the major load whenever possible. Wheels should be configured such that the load is predominantly radial whenever possible.

Normal adjustment is obtained by rotating the eccentric bushings until all free play is removed from the carriage assembly. When the eccentrics are adjusted and the carriage plate is held firmly in place, one should be able to rotate, by hand, any of the four guide wheels in the system against its mating track. If rotation is not possible, preload on the wheels should be reduced accordingly. Overtightening of the eccentric adjustment could result in premature bearing failure. Such a condition can exert a force greater than the load rating of the wheel.

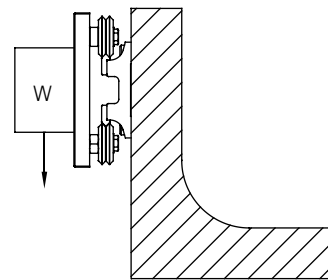


Figure 3: Linear guide configured primarily radial load

## Wash Down Environments

For wash down applications, stand-offs can be used to mount track to a mounting surface, eliminating dirt traps, and allowing for washdown (see sketch below).

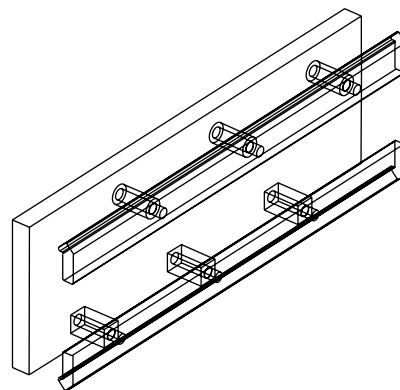


Figure 4: DualVee® track mounted with stand-offs eliminates dirt traps